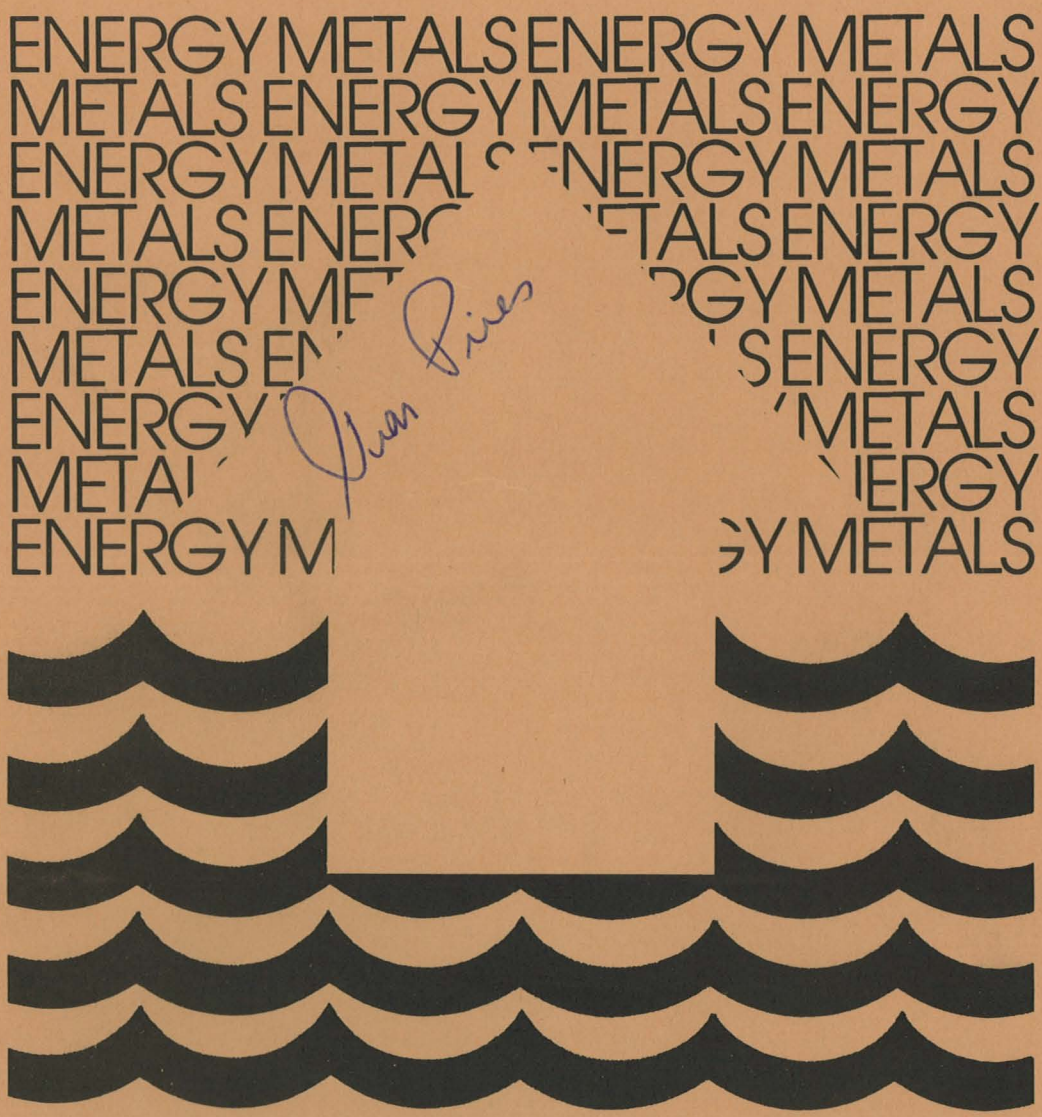

Deep Seabed Mining

Report To Congress

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of Ocean Minerals and Energy
December 1981

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

THE ADMINISTRATOR

December 21, 1981

Honorable George H. Bush
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

It is my honor to transmit the Deep Seabed Mining Report of the National Oceanic and Atmospheric Administration (NOAA) to the Congress pursuant to Section 309 of the Deep Seabed Hard Mineral Resources Act (P.L. 96-283).

This report describes NOAA's progress in implementing the Act, and our continued development of the deep seabed mining program in a legally sound and environmentally sensitive manner. Also discussed are NOAA's efforts in the negotiations of agreements with foreign nations to facilitate reciprocating states arrangements to provide an interim legal regime for sea-bed mining pending an acceptable Law of the Sea treaty, and our outlook for the future of deep seabed mining.

Sincerely,

John V. Byrne

nclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

THE ADMINISTRATOR

December 21, 1981

Honorable Thomas P. O'Neill
Speaker of the House of Representatives
Washington, D. C. 20515

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Sincerely,

John V. Byrne

Enclosure

Deep Seabed Mining

Report To Congress

Prepared by:
Office of Ocean Minerals and Energy
2001 Wisconsin Avenue, N.W.
Washington, D.C. 20235

December 1981

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

Office of Minerals and Energy
James P. Lawless, Acting Director

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Overview

The world's most valuable known supply of manganese nodules lies three miles deep in international waters of the Pacific Ocean between Central America and Hawaii. Rich in strategic metals, these fist-sized nodules are being explored and analyzed by five international industrial consortia, four of which include U.S. companies. The metals -- copper, nickel, cobalt, and manganese -- are essential for the production of steel, aircraft engines, alloys, and other industrial materials. The United States currently imports large quantities of these metals, including virtually all of its cobalt and manganese. Zambia and Zaire provide most of the world's cobalt. By the end of the century, the Soviet Union and South Africa are expected to control virtually all the world's manganese resources. An independent, secure supply of these resources would preclude interruptions of supply or monopoly price increases.

Current international law provides no specific system for guaranteed access to a site. Such guarantees are necessary to protect the more than one-billion-dollar investment ultimately needed to undertake deep seabed mining. Although an international Law of the Sea treaty presently is in the process of negotiation, the current regime for deep seabed mining is based on national law, which provides for deep seabed mining as a freedom of the high seas.

In June 1980, Congress enacted the Deep Seabed Hard Mineral Resources Act (P.L. 96-283), to provide an interim legal framework, pending an acceptable treaty, to facilitate the continued development of deep seabed mining in an orderly and environmentally sensitive manner. The authority for implementing the Act, and for issuing to U.S. citizens licenses for exploration and permits for commercial recovery, was given to the National Oceanic and Atmospheric Administration (NOAA). Within NOAA, authority was assigned to the new Office

of Ocean Minerals and Energy (OME). From the enactment of the law, NOAA proceeded to carry out its responsibilities by assembling and using people and funds from the agency's Marine Minerals Division, other elements of NOAA, and other federal agencies. During this period, the framework for the program was put together.

In pursuing its efforts, OME held a series of public meetings to produce regulations to implement Titles I and II of the Act and to develop environmental information. In March 1981, NOAA issued a Notice of Proposed Rulemaking and a draft programmatic environmental impact statement, as required by the Act. In September, the final regulations (Deep Seabed Mining Regulations for Exploration Licenses, 15 CFR Part 970, at 46 CFR 45890) and a supporting final programmatic environmental impact statement were published on schedule and as required by the Act. At the same time, NOAA issued a technical guidance document to assist license applicants. The regulations established the legal framework for deep seabed mining exploration by U.S. industry.

Aside from a few environmental and exploratory surveys by "grandfather" pioneer companies, no exploration or commercial recovery has been undertaken during the period covered by this report, and consequently there have been no adverse environmental impacts. No legal proceedings have been undertaken and no license or permit applications have been received. NOAA anticipates receiving license applications in early 1982.

The Act also provides for negotiation of mutual recognition of licenses with other nations that have authority to license deep seabed mining, and for NOAA to designate such nations as reciprocating states. To this end, NOAA and the Department of State engaged in negotiations with these nations. The Federal Republic of Germany, United Kingdom and France have enacted

such legislation. At the same time, NOAA began negotiations on establishing stable reference areas, to be used as a baseline zone for evaluation and enviromental assessment, as required by the Act.

In addition, NOAA submitted a report to Congress, on June 24, 1981, dealing with protection of interim investments, pursuant to section 203 of the Act. The agency also prepared a five-year ocean research plan to support environmental assessment studies, as required by the Act. Although the report was reviewed in draft form by appropriate Congressional committees, its formal submission report to Congress was deferred, with the agreement of the committees, pending the Admininstration's review of NOAA's budget.

The programmatic environmental impact statement concluded that some impacts occur in the water column and on the sea floor. In the water column, the impact during commercial recovery may be significant on fish larvae. On the seafloor, organisms will be lost during the actual collection of nodules. However, these impacts are not expected to be significant during the exploration phase. Environmental impacts will be monitored and evaluated during system tests of nodule collection equipment and during commercial recovery. Meanwhile, NOAA will continue to examine potential environmental impacts and their significance.

On shore, environmental impacts can occur in ports and at transfer facilities, as well as during processing and disposal of wastes. While existing controls are generally adequate to protect against adverse impacts, NOAA, in cooperation with other agencies, will examine disposal of wastes to determine whether tailings require special attention. NOAA will serve as the lead agency for environmental review and facilitate other state and federal permits.

NOAA also worked with the Environmental Protection Agency (EPA) to secure a general National Pollutant Discharge Elimination System permit.

EPA intends to issue a general permit for exploration, and has already started working toward that end.

OME has begun pre-application consultations with industry, to ensure prompt processing of license applications and to support site-specific environmental impact statements. NOAA anticipates early designation of initial reciprocating states. With respect to the commercial recovery phase of seabed mining, NOAA has already begun to work on the framework for regulations, in anticipation of commercial recovery, which cannot start under the Act until 1988.

In addition to work under the Act, NOAA will assess other ocean minerals, including the polymetallic sulfide ores recently found at spreading centers between the plates on which the world's continents set. Such valuable metals as copper, zinc, and silver were discovered on the edges of these tectonic plates. NOAA will evaluate their potential and consider environmental research and legal regimes that would have to be established before commercial recovery could take place.

NOAA has reviewed the Act and implementing regulations, and concluded that the deep seabed mining program can be implemented at least until the next biennial report to Congress without modification of the Deep Seabed Hard Mineral Resources Act.

CHAPTER I

Background

The Resource

First samples of what are now called manganese or ferromanganese nodules were recovered from the deep seabed during the 1873-76 research expedition of the HMS Challenger. While information on the occurrence of nodules has accumulated through the years, nodules were largely considered to be a scientific curiosity until approximately 25 years ago, when it was discovered that they contained in addition to manganese, significant amounts of copper, nickel, and cobalt.

While nodules have been found in all of the world's oceans and in some large lakes (e.g., Lake Michigan), commercial interest is centered in the equatorial North Pacific Ocean shown in Figure I. The nodules in this area have metal contents that are of greater commercial interest and have no constituents that complicate metal recovery during processing. Water depths in the area range from 12,000 to 18,000 feet.

Estimates of the number of potential "first generation" mine sites in the Pacific area of interest have varied from a few dozen to several hundred. This variation occurs because of sparse data on the abundance and quality of the resource and different assumptions regarding what tehcnology is needed for "first generation" mining, particularly on an ocean bottom that is not fully understood. Most data on the resource available has been gathered as part of on-going research sponsored by the National Science Foundation on the origin of nodules. While this data is scientifically valuable, it is not particularly suitable for estimating the total resource. In any case, the potential resource can be considered large.

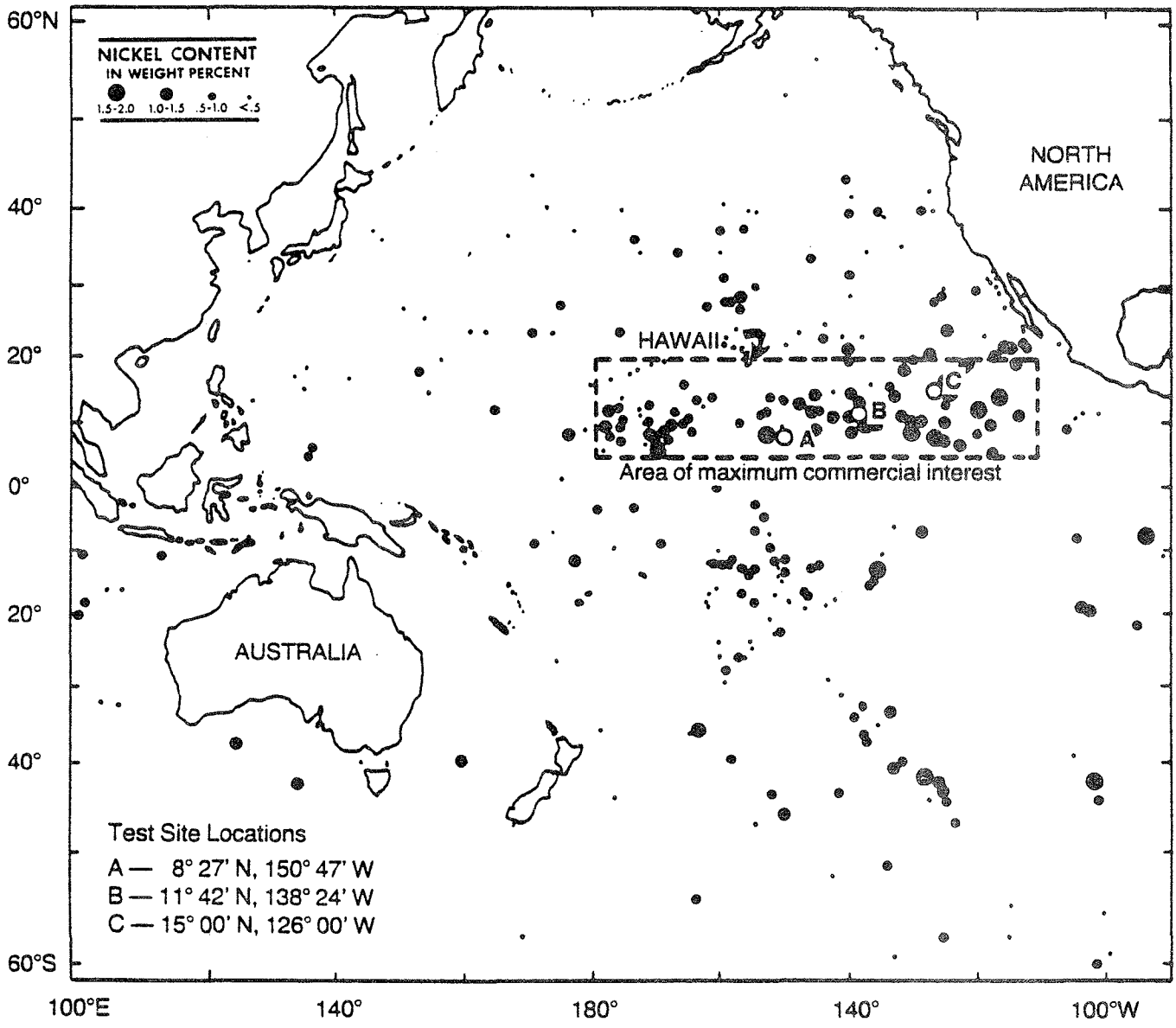

Figure 1.--Area of manganese nodule maximum commercial interest and high nickel concentration in nodules with DOMES test site locations (Horn, Horn, and DeLach, 1972).

With respect to technology, private sector research and development programs are still underway, and any projections on the mining efficiency of first generation commercial systems must be considered speculative.

The National Interest

Development of manganese nodule resources by the U.S. private sector would provide the United States with: (a) a stable supply of metals important to the economy at competitive prices, (b) a reduced annual balance of payments deficit, (c) increased investment in a basic industry, (d) regional employment benefits, and (e) continued leadership in new ocean technologies.

Recent studies have concluded that supply and price problems may be encountered with cobalt and manganese in the not-too-distant future. The availability of copper and nickel does not raise the same concern, however, because the United States is the world's largest copper producer--although it still imports up to 20 percent of its supply--and nickel supplies are diverse and controlled by nations generally friendly to the United States. Cobalt production in the non-communist world is centered in the African nations of Zaire and Zambia and, until nodule resources are developed, these countries will remain the dominant source of supply. The majority of the United States' supply of manganese comes from South Africa, Australia, and Brazil. However, it is projected that in the next 15 to 25 years the non-communist world's onshore reserves will be centered in South Africa. The only other onshore reserve is in the Soviet Union. Based on events in the last decade, political stability on the African continent cannot be predicted, making at least temporary supply interruptions possible. In addition, as the sources of supply become more concentrated, the ability of mines on land to meet world demand can become a factor in determining both supply and price. The

commercial recovery of nodules from the ocean would provide a stable source of supply and the resultant competition would help moderate increases in the price of metals. Indeed a significant drop in the price of cobalt could be forecast.

The U.S. annual balance of payments deficit from imports of copper, nickel, cobalt, and manganese varies from year to year. In general, the net deficit is on the order of $1.5 billion to $2 billion per year. If the nodule resource is developed and nodules are processed under U.S. jurisdiction, the United States would likely become a net exporter of these metals.

In addition, deep seabed mining will lead to an increase in the U.S. industrial base and create, regionally, new jobs. The U.S. industrial base has been declining over the years, as the United States has become an importer of more and more finished and semi-finished products rather than of raw materials. Each deep seabed mining venture will require a capital investment of $1 billion to $1.5 billion in what can be considered a "basic" industry. In addition, each venture will provide a significant number of sea-going and onshore jobs. For example, each mineship will have a crew of perhaps 160 to 200. A typical operation may employ two mineships. An onshore processing plant could be expected to employ directly 500 to 600 people. Other jobs would be created in a number of fields during construction of commercial-scale systems.

A commercial operation will require new technology and new applications of existing technology. If commercial development takes place largely under U.S. auspices, it will help extend the United States' ability to develop ocean resources in general and will help assure a continuing U.S. role as the supplier of high technologies.

Nature of the Industry

The four multi-national private sector consortia with U.S. participants are developing the information and equipment needed to design, build, and

operate an integrated deep seabed mining system. The private sector consortia and their participants are listed in Table I. In addition, there are national efforts, with government leadership, to develop deep seabed mining information, technology, or both, underway in France, Japan and Norway. And there is some direct financial support of their participants in the private sector consortia by the governments of Germany, Italy, and the United Kingdom.

In order to engage in commercial-scale deep seabed mining, a potential operator must have: (a) an identified mine site with an adequate resource to sustain the venture for its economic life of 20 to 25 years, (b) sufficient knowledge of oceanic conditions at the mine site to design the mining device, (c) a proven method of producing a continuous flow of nodules to a surface platform, (d) an efficient method to produce products from the nodules, and (e) methods for providing all of the support services required for nodule recovery and processing. Such support includes at-sea and onshore nodule transportation, including transfering nodules between the mineship and nodule transport vessels; providing detailed maps to the mineship of areas to be mined; refueling, resupplying, and recrewing the mineship; providing energy and other raw materials to the processing plant; and transporting and disposing of processing wastes.

Development of nodule recovery and processing technologies is key to the venture, but the importance of being able to supply the support services cannot be ignored. The status of private sector development programs is described in Chapter III.

In addition to possessing a techological capability to engage in commercial deep seabed mining, a potential operator must have the ability to obtain needed capital and legal authorization.

Table 1. Deep seabed mining consortia involving United States firms including dates of consortia formation.

Nation	Kennecott Corp. (1/74) *Sohio & BP	Ocean Mining Associates (OMA) (11/74)	Ocean Management Inc. (OMI) (5/75)	Ocean Minerals Company (OMCO) (11/74)
United States	Kennecott Corp. Noranda Exploration, Inc.	Deepsea Ventures, Inc. (Tenneco and *) *Essex Minerals Co. (U.S. Steel) *Sun Ocean Ventures, Inc. (Sun Oil)	Sedco, Inc.	Ocean Minerals Inc. (Lockheed Missiles & Space Co.; Billiton**; BRW***) AMOCO Ocean Minerals Co., (Standard Oil Co. of Indiana) Lockheed Systems Co., Inc. (Lockheed Corp.)
Belgium		*Union Seas, Inc. (Union Miniere)		
Canada			INCO, Ltd.	
Italy		*Samin Ocean Inc. (Subsidiary of Italian Govt.)		
Japan	Mitsubishi Corp.		Deep Ocean Mining Co., Ltd.	
Netherlands				**Billiton B.V. (Royal Dutch Shell) ***BRW Ocean Minerals (Royal Bas Kalis Westminister Group N.V.)
United Kingdom	R.T.Z. Deep Sea Mining Enterprises, Ltd. Consolidated Gold Fields, Ltd. BP Petroleum Dev., Ltd.			
West Germany			AMR	

NOTE: Asterisks show relationship of subsidiaries to their parent companies.

CHAPTER II

The Domestic Legal Regime

The Deep Seabed Hard Mineral Resources Act

In the mid-1970's, legal access to manganese nodules in international waters became a focus of the Third United Nations Conference on the Law of the Sea. Although deep seabed mining issues continue to be a topic of discussion at these sessions, there still remains a wide difference of opinion as to the appropriate nature of access to the nodules. The United States and several other industrialized nations that have already begun preliminary exploration would like relatively unimpeded development of the seabed mining industry. On the other hand, less developed nations and certain land-based metal-producing developed countries, have expressed concerns over the equitable distribution of resources from such international areas. These countries have proposed restrictions to such access.

Thus, uncertainties were created by the Law of the Sea negotiations with respect to the legal status of miners. U.S. companies found themselves in a dilemma: they could not continue indefinitely to risk their own investment nor could they obtain from financial institutions the enormous capital (which could total over one billion dollars for each venture) to exploit those resources commercially. Yet they knew negotiation of the access issue through a Law of the Sea treaty might be years away.

As a result, members of the American mining community sought domestic legislation to provide further legal certainty as to their rights to mine seabed areas in which they had begun to invest significant sums.

Enactment of the Deep Seabed Hard Mineral Resources Act in June 1980, culminated over eight years of Congressional effort to pass legislation to promote development of a U.S. industry to commercially recover and process hard minerals resources of the deep seabed.

Congressional interest in manganese nodules as a source of strategic minerals actually began in 1969 when access to those minerals became the subject of hearings before a special Subcommittee on the Outer Continental Shelf. Legislation was introduced and debated during the 92nd, 93rd, 94th Congresses. Throughout those debates, the Executive Branch counseled delay in pursuing domestic legislation. The overriding concern was that unilateral action on the part of the U.S. could seriously jeopardize the ongoing Law of Sea negotiations.

During the 95th Congress, the Administration endorsed passage of the legislation. By the beginning of the 96th Congress, the need for an interim legal and regulatory framework pending implementation of a Law of the Sea treaty was more widely recognized. A domestic legal regime was essential in creating the investment stability necessary for U.S. companies to continue the development of a seabed mining industry.

On February 26, 1979, S. 493 was introduced to encourage successful completion of a comprehensive Law of the Sea treaty and to create an interim legal and regulatory framework for seabed mineral exploration and development. After hearings before the committees on Energy and Natural Resources; Environment and Public Works; Commerce, Science and Transportation; Foreign Relations; and Finance, the Senate passed S. 493 by voice vote in December 1979. As passed, S. 493 designated NOAA as the lead agency for a domestic seabed mining program.

In the House, debate focused on a similar bill, H.R. 2759. By the spring of 1980, slightly different versions of H.R. 2759 had been reported by the House committees on Interior and Insular Affairs, Merchant Marine and Fisheries, and Ways and Means. One of the key differences between the Committee-passed versions was the designation of lead agency responsibility.

The Administration supported the Department of Commerce and NOAA as the lead agency because of NOAA's experience gained through its Deep Ocean Mining Environmental Studies.

The House Foreign Affairs Committee deferred action on H.R. 2759 at the Administration's request until after the spring 1980 session of the Law of the Sea negotiations. In April 1980, the Administration expressed support for H.R. 2759 if Congress would agree to amendments that would more closely conform the domestic legislation to transitional provisions of the LOS text. The amendments deferred the earliest date for commercial recovery from 1982 to 1988 and directed the Secretary of Commerce within a year after enactment to propose legislation to accommodate a system to protect interim investments adopted by the LOS Conference.

The four House committees worked during the week of June 2 to develop a composite version of H.R. 2759, which was offered on the House floor as a substitute. On June 9, this composite version, designating the Department of Commerce, NOAA, as lead agency, was passed by the House of Representatives.

Work began immediately to reconcile the differences between H.R. 2759 and S. 493. Those differences primarily involved:

- A Senate requirement for U.S. construction as well as documentation of seabed mining vessels (the final version requires only U.S. documentation);
- A Senate requirement for U.S. siting of processing plants, adopted with some modification in the final version; and
- A House provision for cost/benefit analysis of (a) modification of terms, conditions and restrictions in licenses and permits, and (b) the application of amended regulations, both deleted or narrowed in the final version.

On June 23, the Senate passed an amended version of H.R. 2759, and the House concurred with the Senate amendments on June 25. On June 28, 1980, the Deep Seabed Hard Mineral Resources Act was signed into law.

The new law establishes an interim program to regulate exploration for the commercial recovery of deep seabed manganese nodules by U.S. citizens. In particular, the Act provides a mechanism whereby citizens who meet the requirements in the law may obtain priority of right and assured access to engage in deep seabed mining exploration and, eventually (beginning in January 1988), commercial recovery within high seas areas selected by the companies. It also provides for recognition of the authorized activities of miners from other nations, if such nations have developed compatible mining programs that recognize authorized activities of U.S. miners.

Seabed Mining Exploration Regulations

The Act requires the National Oceanic and Atmospheric Administration to issue implementing regulations. Within the period specified in the Act, NOAA issued proposed deep seabed mining regulations for exploration licenses (on March 24, 1981) and final regulations (on September 15, 1981). These regulations will carry out the purpose of the statute by establishing an element of legal certainty, as needed by the industry, while assuring that development occurs in a responsible and environmentally sensitive manner. They recognize the need for flexibility in order to promote the development of deep seabed mining technology, and the usefulness of allowing initiative in behalf of miners in this regard.

In developing these regulations, NOAA encouraged public participation. On July 28, 1980, NOAA published in the Federal Register and distributed

an advance notice of proposed rulemaking. In November 1980, after considering the responses received on the advance notice, NOAA widely distributed and sought comments on a discussion paper on the major issues to be addressed in forthcoming regulations, and a notice was published in the Federal Register. Also, a public hearing was held to receive comments on the paper. With the benefit of these earlier comments, NOAA published the proposed rules and invited comments on them. More public hearings were held in Honolulu, San Francisco and Washington, D.C. Comments on the proposed rules were received from 25 sources, including industry, state representatives, environmental groups, universities and other federal agencies.

The current regulations deal only with the requirements and procedures for exploration licenses. It was clear from the outset that it was unnecessary to issue regulations for commercial recovery permits since the Act prohibits commercial recovery until January 1, 1988, and current explorers have said they do not intend to file for commercial recovery permits until 1984 at the earliest.

During the interim, however, NOAA and the industry will gather the information necessary for a reasoned approach to commercial regulations. Meanwhile, the present exploration regulations will allow miners to establish legal priorities in selected seabed areas and to continue exploration.

Not all of a company's exploration work is covered by NOAA's regulations. In drafting the regulations, NOAA sought to assure applicants that they would have to provide only the information necessary for agency determinations and other requirements specified in the Act. The major issues addressed in the regulations are as follows:

1. The information needed to determine the applicant's financial responsibility to engage in the proposed exploration.

2. The information needed to determine the applicant's technological capability to undertake the proposed exploration.

3. The information specified for an applicant to include in the exploration plan.

4. The information or analysis to require on, and basis for evaluating potential environmental effects from, exploration activities.

5. The appropriate approach to the Act's National Pollutant Discharge Elimination System requirements.

6. Information to facilitate the required antitrust review of an application.

7. Criteria and procedures for resolving overlapping applications by pre-enactment explorers.

8. Criteria for evaluating the proposed size and location of an exploration area.

9. Criteria for resolving potential conflicts on uses of the high seas and other international conflicts.

10. Criteria for determining whether there are undue threats to the safety of life and property at sea.

11. Criteria for what changes require revision to a license.

12. Criteria for terms, conditions and restrictions to be included in the license to ensure diligent exploration.

13. Criteria for terms, conditions and restrictions in licenses relative to monitoring and mitigating environmental impacts.

14. Terms, conditions and restrictions in licenses to avoid waste during mining and allow the opportunity for future recovery of the unrecovered balance of nodules.

As part of its effort in developing its regulations, NOAA prepared an impact analysis of the regulations. In analyzing regulatory approaches that could be taken, NOAA determined that they fell into three broad groups:

1. Fixed regulations.

2. Flexible regulations preceding license issuance.

3. Flexible regulations both preceding and following license issuance.

In considering which of these alternative approaches would be most appropriate for the various regulatory provisions, NOAA attempted to avoid alternatives that would impose unnecessary or ineffective regulation on miners. The choices involved the following considerations:

1. Fixed regulations.

Fixed regulatory measures allow little flexibility on the part of the applicant and the agency. Under some circumstances, fixed regulations could have the effect of restricting the development of deep seabed mining technology by reducing innovation to develop mining techniques and systems. However, under other circumstances, the certainty provided by fixed regulations is a distinct benefit in terms of reducing costs because all participants know in advance what costs requirements must be met. For example, NOAA adopted a fixed approach for the numerous procedural provisions in the regulations to conform to the Act and to provide the certainty for which procedures are intended. For most regulatory provisions, however, a fixed regulatory approach was deemed to be less beneficial than other approaches.

2. Flexible regulations preceding license issuance.

The principle benefit of this method is that it provides guidance to companies in advance of their filing license applications, yet allows the flexibility that may be necessary to take account of differing

characteristics and factors related to each applicant. Nevertheless, NOAA kept in mind that, in certain instances,, this approach may provide insufficient guidance and certainty to companies, and thus possibly could lead to unnecessary expenses incurred complying with the regulations. Also, even though this alternative provides some flexibility, its use would have been premature, unnecessary under the Act, and thus unduly restrictive with respect to criteria for addressing some regulatory issues. These issues were addressed more appropriately in the context of the third approach discussed below.

3. Flexible regulations both preceding and following license issuance.

This approach allows NOAA to continue its review and consideration of exploration activities even after a license is issued. Thus, the unique characteristics of individual applicants and sites receive maximum consideration by allowing miners to proceed until more information is obtained or until an undesired event occurs. This approach provides the benefit of flexible guidance to applicants for the issuance of a license, like the second alternative, yet allows the additional benefit of not imposing undue requirements on an applicant and on NOAA when such requirements are unnecessary for agency determinations prior to issuing a license. Such an approach is consistent with the Act. The chief cost of this approach, which NOAA also considered, is that the lack of firm guidelines may not provide necessary guidance and certainty for determinations that must be made before issuing licenses. This may create an undue hardship for industry though inefficient planning, and also could be viewed as creating a potential hardship for society by raising costs associated with monitoring the federal program.

The Licensing Process

NOAA's regulations establish the procedures for license application.

In addition, staff members from the Office of Ocean Minerals and Energy (OME) are available for discussions with license applicants before any formal application is submitted. During this pre-application stage, the applicant can indicate the general plan for exploration, and possibly present an outline. These consultations can continue up to the time of filing, and beyond.

The Act and its regulations also require review and consultation with eleven federal agencies: the departments of Defense, Interior, State, Labor, Justice, Treasury, and Transportation (the Coast Guard), as well as the National Science Foundation, Small Business Admininstration, Environmental Protection Agency, and Federal Trade Commission. OME has worked with these agencies and continues to advise them about the licensing program to learn of any concerns they may have.

NOAA also is working to assure that its licensing process will be compatible with those of other nations with deep seabed licensing authority. NOAA's review of initial applications is being conducted in parallel, and in communication, with other countries that are reviewing license applications for pre-enactment explorers.

NOAA expects to receive license applications beginning in January 1982. The federal consultation process and required public notice will begin with the receipt of applications. The process also will include resolution of conflicts among initial applicants whose applications cover the same area of the seabed. Applicants will be encouraged to resolve conflicts by negotiation. If this fails, domestic conflicts will be submitted to NOAA for resolution, and international conflicts will be resolved by procedures agreed upon with other seabed mining nations.

The regulations call for a public hearing on the license application and any supporting site-specific environmental impact

statements. In addition, NOAA will be available to meet with members of the public or other groups, if necessary.

The Act and regulations are specific about conditions and restrictions required in any licensing action. Specific findings are needed in conjunction with substantial compliance, certification, and issuance actions by NOAA. Findings will address a number range of topics, such as an applicant's financial resources, technological capabilities, and the adequacy of its exploration plans, as well as the broader issues of environmental impacts, vessel safety, anti-trust activities, the size and location of explorations areas, freedom of the high seas, safety of life and property at sea, and environmental monitoring. Reciprocating states will require similar information as they review license applications filed under their own jurisdiction.

CHAPTER III

Technology for Exploration and Commercial Operations

Mining Systems and Operations

The international deep seabed mining consortia already mentioned were formed in the 1970's to share the cost of exploring for and mining manganese nodules and developing systems to process them. These consortia have been working on two main types of mining systems: hydraulic and continuous line bucket (Figure 2). Hydraulic systems, using either submerged centrifugal pumps or air lift systems, are favored by the consortia involving United States corporations. The Japanese and French are pursuing the continuous line bucket system.

Hydraulic mining systems recover nodules in a seawater slurry pumped through a pipeline from a seafloor collector to a mining ship on the surface. During nodule collection, bottom water, sediments, and macerated biota are drawn into the collector. Most of this extraneous material is ejected near the seafloor. However, some material travels up the pipeline and is discharged at the sea surface. In some systems, nodules may be crushed at the lower end of the pipeline to improve the efficiency of the system.

The hydraulic collector can be either towed or self-propelled. Towed collectors rest on the seafloor and are towed by the surface vessel. The Ocean Minerals Company's Archimedes screw design is the only self-propelled system. It provides a greater degree of control in keeping the collector on a pre-determined course. The hydraulic collector sweeps the bottom in nearly adjacent swaths. Each swath may be up to 20 meters (65 feet) wide.

Estimates by industry indicate that mining vessels will operate 24 hours a day for an average of 300 days a year. Mechanical overhaul, transit, and downtime for bad weather will account for the remainder of the year's operations. Within a given mine site, mining will probably

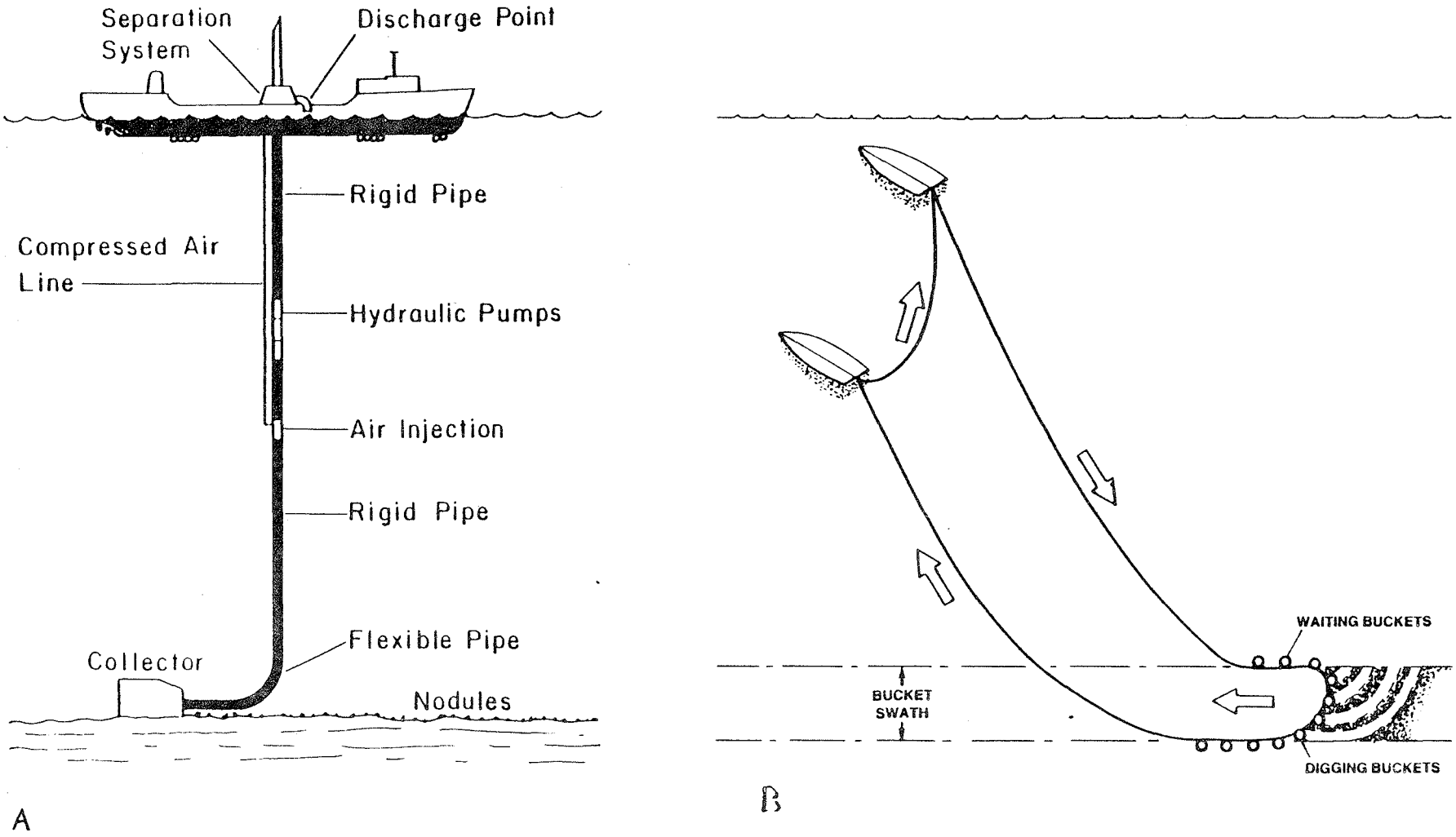

Figure 2.--Diagrams of two major mining systems. (A) Hydraulic pumping and compressed air lifting (both have been used) (Burns, et al. 1980); (B) continuous line bucket (conceptualized by NOAA).

take place within one sub-area about of 900 square kilometers (260 nautical square miles), with approximately 25 percent of this area unmineable because of rough topography or low nodule concentration. Industry anticipates an average production of 5000 metric tons of dry nodules per day per ship. The nodules will be transferred in a slurry through a flexible hose from the mine ship to an ore carrier for transporation to shore.

Onshore Activities

The onshore aspect of deep seabed mining involves four major activities: the use of port facilities, transportation of nodules from port to processing plant, processing the nodules, and disposal of processing wastes.

Port facilities will consist of a marine terminal for unloading the nodules and temporarily storing them onshore. If the nodules are unloaded in a slurry, they can be transported to an inland processing plant via pipeline. If they arrive ground and dried, transportation will likely be by conveyor, truck, or rail.

A key element in determining the type of onshore processing plant depends on whether three or four of the metals in the nodules would be extracted. A "three-metal" plant would extract copper, nickel and cobalt as "primary products," and could produce "secondary products" such as molybedenum. A four-metal plant would, in addition, recover manganese. The near-term market for manganese will, in large part, determine if that metal will be extracted. Because of the high percentage of manganese in nodules (25 percent average), a company must balance the scale of operations needed to make its effort economical against its ability to penetrate the near-term manganese market. One alternative to a four-metal operation is a three-metal plant with manganese-rich wastes stockpiled as a by-product. Although all of the consortia have conducted small-scale

tests on nodule processing, larger scale tests will probably be needed before commercial-size plants can be built.

Industry has given some consideration to nodule processing at sea. However, primarily because of problems caused by ship motion, complete processing of nodules at sea is currently not possible. The development of the necessary new technology is not considered likely during first generation mining. Although upgrading the nodules by physical means, called beneficiation, is not currently possible, partial treatment to produce an intermediate product could take place. If either complete or partial at-sea processing is proposed by industry, NOAA will prepare a supplement to its programmatic environmental impact statement.

The amount of waste produced and its chemical and physical properties vary greatly depending on the process used, particularly between three- and four-metal processes. Two of the major concerns with waste disposal are the large quantities of wastes (3 to 4 million metric tons annually for a three-metal plant; 0.5 to 0.75 million metric tons annually for a four-metal plant) and the unknown chemical and physical characteristics of the wastes. The deep seabed mining industry is expected initially to follow typical land mining disposal practices, using either containment structures, known as tailing ponds, or landfills. Waste disposal at sea offers economic advantages to industry, but the legality of ocean dumping has not yet been determined.

Recent exploration activities

During the period since passage of the Act, several companies have collected resource and environmental information using sonar, TV, camera equipment and free fall grab nets, and have checked out survey equipment. These activities will assist in preparing applications, provide additional information which is useful for further exploration voyages, and increase the data base on resources and the types and frequency of marine species.

CHAPTER IV

Environmental Considerations

Programmatic Environmental Statement

NOAA, in consultation with the U.S. Environmental Protection Agency and with the assistance of other federal agencies, has prepared a final programmatic environmental impact statement (PEIS). The PEIS assesses the environmental impacts of licensed exploration for and permitted commercial recovery of manganese nodules in the eastern equatorial Pacific Ocean (sometimes referred to as the DOMES area), where United States citizens are most likely to engage in mining.

The main purpose of the PEIS is to assess the environmental impacts from exploration and initial commercial recovery, including alternative approaches to exercising regulatory authority and programmatic approaches to mitigation and monitoring that are addressed in the regulations and a related Technical Guidance Document issued by NOAA. In addition, the PEIS provides the appropriate environmental assessment for reciprocating states agreements between the United States and other nations beginning seabed mining.

The scope of the PEIS is limited to first generation mining, that is, the industry as it initially develops on a commercial scale during the late 1980s and throughout the 1990s. The NOAA document considers mitigation measures which may be appropriate. For the present, however, it concludes that such measures are premature, and proposes the monitoring of activities to provide additional information and to serve as the basis for future decisions. The PEIS is comprehensive so that information required later in site-specific environmental impact statements pertaining to individual license applications will be reduced. If new technology is developed, or if operations outside the DOMES area are undertaken,

or at-sea processing of nodules becomes feasible, a supplement to the PEIS or a new PEIS may be prepared.

When deep sea mining was first proposed, NOAA recognized the importance of acquiring an environmental data base against which the impacts of manganese nodule recovery could be measured. NOAA began the Deep Ocean Mining Environmental Study (DOMES) program in 1975 as a comprehensive five-year research effort to gather this data. DOMES had two phases. The objectives of DOMES I were to establish environmental baselines at three sites typical of the environmental conditions likely to be encountered during mining, to develop a first-order predictive capability for determining potential environmental effects of nodule recovery, and to help develop an information base for the preparation of environmental regulations for industry and government. DOMES II involved the monitoring of industrial, at-sea, pilot-scale mining tests conducted in 1978. The objectives here were to observe actual environmental effects to improve the ability to predict impacts, and to refine or modify the information base on which subsequent environmental regulations would be based.

The DOMES project showed that many of the activities that initially raised concerns about deep seabed mining were unlikely to have a significant adverse environmental impact. Table 2 shows the status of all the environmental impacts. Although these activities appear to pose no immediate threat to the environment, they will be examined closely during mining system tests and during actual commercial recovery. Mapping and sampling will have no adverse effect on the environment.

NOAA research has shown that there are three potentially adverse effects of deep seabed mining: destruction of benthos in and near the collector tract, blanketing of benthos and the dilution of its food supply away from the mine site, and the surface plume effect on fish larvae. As the collector moves across the seafloor, organisms living in

Table 2. Deep seabed mining perturbations and environmental impact concerns

MINING PERTURBATIONS

	STATUS OF CONCERNS *	BENTHIC IMPACT		SURFACE DISCHARGE	
		COLLECTOR CONTACT	BENTHIC PLUME	PARTICULATES	DISSOLVED SUBSTANCES
CONCERNS WITHOUT POTENTIAL FOR SIGNIFICANT OR ADVERSE IMPACTS	Low Probability of Impacts	Light from collector	Nutrient or trace metal increase	Bacteria growth deplete oxygen	Trace metals effects on phytoplankton
			Oxygen demand	Alter phytoplankton species composition	Nutrient increase cause phytoplankton blooms
				Affect fish	
				Zooplankton mortality and species composition and abundance changes in plume	Airlift caused embolisms
				Trace metals entry into food web	
	Impacts Not Yet Resolved	Not Applicable	Not applicable	Pycnocline accumulation	Not applicable
	Potentially Beneficial Effects	Additional food supply for bottom scavengers	Not applicable	Bacteria increase food supply for zooplankton	Not applicable
				Filterfeeding zooplankton fecal pellets clean up plume	
	Certain Impact Without Significant Adverse Effects	Not applicable	Not applicable	Increased turbidity reduce productivity	Not applicable
CONCERNS WITH POTENTIAL FOR SIGNIFICANT OR ADVERSE IMPACTS	Certain Impacts	Destroy benthos in and near track	Not applicable	Not applicable	Not applicable
	Unresolved Impacts	Not applicable	Blanket benthos; dilute food supply away from mine-site sub-areas	Affect fish larvae	Not applicable

*NOTE: Status of concerns is to be verified during demonstration-scale mining system tests, prior to commercial mining

its path will be destroyed and those living between swaths will most likely be smothered by heavy sediment. The fine sedimentary particulates in the benthic plume, called "fines," move with bottom currents away from the mine site. The resulting sedimentary blanket may smother bottom feeders and interfere with their food supply. Although the destruction of the benthos by the collector is clearly adverse, neither its impact nor that of the blanketing appears to be significant. The better understanding of both effects will, however, be a goal of future NOAA research and in the monitoring of industry test mining.

The third potentially adverse impact involves the effect of the surface plume on fish larvae. The physical characteristics of the plume could kill larvae or alter their behavior. This effect will also be examined in NOAA's research and monitoring.

The remaining uncertainties associated with these three main environmental concerns were considered by NOAA in the development of two additional documents, a Technical Guidance Document and the Deep Seabed Mining Marine Environmental Research Plan 1981-1985. The Technical Guidance Document provides more detailed guidance for applicants on an approach, which will put the burden of proof on industry through a self-monitoring program, to provide sufficient data to aid in resolving the three main environmental concerns and to verify other conclusions of the PEIS. The five-year research plan emphasizes the three main environmental concerns and assumes that they can be resolved by a combination of industry self-monitoring and government research.

Technical Guidance Document

The Technical Guidance Document was developed by NOAA to provide assistance to the industry's environmental specialists. It will help them compile information to submit to NOAA when they request an exploration license and when they test their mining equipment. This information will

will be used by NOAA:

1. To assess the environmental aspects of exploration proposed in a license application and to prepare site-specific environmental impact statements;

2. To develop conditions for each applicant, following review of monitoring plans, to assure that the effects of mining tests agree with the effects predicted in the site-specific EIS and to assure that any anticipated adverse effects can be detected;

3. To further refine estimates of the potential effects of commercial mining, based on system testing, in order to prepare environmentally sound regulations and guidance for commercial recovery under a NOAA permit; and

4. To relate the new data to the objectives of NOAA's 5-year research plan.

The guidance provided in this document is based on the sampling and test monitoring of the DOMES project and the analyses in the programmatic environmental impact statement.

Five-Year Research Plan

The Deep Seabed Hard Mineral Resources Act required the implementation of a marine research program to assess the environmental effects of exploration and commercial recovery. The law specifically identifies elements to be in the research program, including natural diversity of the deep seabed biota, life histories of major organisms likely to be impacted, long-and short-term effects of commercial recovery on deep seabed biota, and effects of seabed processing. The law requires that this research program be documented and submitted to the Congress.

Accordingly, NOAA has prepared a Five-Year Marine Environmental Research Plan that assesses and ranks the scientific needs over the next

five years pertaining to potential environmental effects from mining and the ocean disposal of processing wastes. Research is aimed at improving the understanding of the significance of the three previously mentioned environmental concerns and their potential for adverse effects; developing a long- and short-term monitoring program; identifying the characteristics of processing wastes, their biological impacts, and alternate methods of their disposal; and evaluating the need and effectiveness of mitigation measures.

CHAPTER V

International Implementation -- Reciprocating States Negotiations

Section 118 of the Act authorizes the Admininstrator of NOAA, in consultation with the Secretary of State and the heads of certain other departments and agencies, to designate any foreign nation as a reciprocating state if the Secretary of State makes certain determinations with respect to such foreign nation. These provisions require that the other nation regulate deep seabed miners under its jurisdiction in a manner compatible with the provisions of the Act and its implementing regulations.

The provisions also require:

o That the nation recognize licenses and permits issued under the Act and comply with the date for issuance of licenses and the effective date for commercial recovery permits specified in the Act;

o That it recognize priorities of right for applications consistent with those provided in the Act and its implementing regulations; and

o That it provide an interim legal framework for deep seabed mining which does not unreasonably interfere with the interests of other states in their exercise of the freedoms of the high seas, as recognized under general principles of international law.

The Act further authorizes consultation with such foreign nations in order to facilitate their designation as reciprocating states, and authorizes the negotiation of agreements with foreign nations necessary to implement section 118.

Reciprocating state agreements and related designations will establish a legal mechanism through which the various mining nations can recognize applications filed with and licenses granted by one another. This complements

the legal recognition and certainty which U.S. companies obtain under domestic licenses and permits issued under the Act. Like the domestic framework, such reciprocal arrangments are envisioned as interim, pending the entry into force for the U.S. of an acceptable Law of the Sea treaty.

In consultation with the State Department and other departments and agencies, NOAA has been actively pursuing the implementation of section 118 of the Act. Since August of 1980, NOAA has consulted with other seabed mining nations to develop the understanding that can provide a common framework under which the various nations' companies can continue with their efforts in deep seabed mining exploration. To date, the Federal Republic of Germany, the United Kingdom, and France have passed similar legislation for the licensing of their citizens. These nations have engaged in productive discussions with the U.S, with a view toward meeting the objectives of the U.S. law.

Generally, these discussions have dealt with the resolution of potential conflicts or overlaps from the initial applications of pioneer explorers under the various national laws, procedures for recognizing priorities of right for new entrants, issues relating to the harmonization of national seabed mining regulatory programs, and technical issues relating to communications among reciprocating states. In particular, the discussions have dealt with such topics as a commitment not to authorize the commencement of commercial recovery until 1988, cooperation in the development of regulatory requirements and research projects on the environmental effects of deep seabed mining, the principles to be employed in resolving conflicts, the size and shape of exploration areas, and the standards for assuring diligence in pursuing seabed mining activities.

In addition, NOAA initated discussions with reciprocating states on establishing international stable reference areas. These areas would be similar to those covered by permits and would serve as controls against which the environnmental effects of seabed mining could be measured. If such areas were established, mining and testing of major equipment would be prohibited in them.

CHAPTER VI

The Future for Deep Seabed Mining

Impediments to Further Industrial Development

The primary impediment to commercial deep seabed mining is the lack of an investment climate suitable to commit literally several hundreds of millions of dollar per venture for further research and development. Other impediments include currently depressed prices of the metals and concern about the domestic economic situation.

There are three major factors in evaluating the investment climate: the uncertain nature of the future legal and political environment, the economic performance of the venture, including that as influenced by government actions, and the enviromental risks.

The major factor regarding the legal and political future of seabed mining is that a consortium could spend enormous sums in research and development only to find it is unable to apply commercially the information and technology it has developed. As noted in Chapter III, each consortium is expected to have to engage in further resource assessment surveys and further research and development before it will be able to decide whether or not to build a full commercial system. Depending on the technical approach used -- for example, at what scale the nodule recovery systems and the processing technique are tested for reliability, endurance and efficiency -- further research and development could cost between $175 million and $300 million. Resource surveys would cost perhaps another $10 million per year. If a consortium were unable to obtain a "contract" or approval from the International Seabed Authority, which would be established under the current draft LOS treaty, much of this money would be lost. These and similar issues raised by the LOS treaty

text are being reviewed by the Administration, under the leadership of the State Department.

The economic future of deep seabed mining is similarly uncertain. Put simply, no one knows if initial deep seabed mining ventures will be profitable. The predicted performance for a deep seabed mining project can be adversely affected by the high early cost of research and development and the long time lag between the initial investment and the receipt of first revenues. In addition, the long operating period and the lengthy startup period create another problem: both metal prices and the structure of metal markets must be predicted over an extended period of time. There is a real risk that major changes could occur, including technological advances in product consuming industries, between the commitment to the research and development and the time the venture goes into commercial production.

The potential investor also faces what could be called an environmental risk, since the Act requires that no significant adverse effects occur from deep seabed mining. Potential investors are concerned that some unanticipated major adverse effect would be detected after mining operations begin, forcing a suspension of mining until a solution could be found and changes made. No amount of environmental research in advance of initial commercial operations can completely eliminate this risk. However, a sound program involving industry, government, and the public that addresses these concerns will reduce this risk. Such a program would include the monitoring of environmental effects of mining combined with the findings already made in NOAA's PEIS.

The investment climate, coupled with the other impediments mentioned earlier, cause NOAA to expect that industry's plans for further research and development during the next several years, as expressed in initial license applications, will be quite conservative. If the situation improves, particularly with respect to the legal-political environment, several parts of the schedule

could be accelerated. NOAA also expects differences in technical approaches. Different consortia obviously can have different ideas on how large a test mining system must be in order to demonstrate the capability to recover nodules commercially. Similarly, there can be different views on when the tests of various components should take place.

Recently Discovered Deepsea Hard Minerals

Scientists sponsored by the National Science Foundation and scientists from NOAA, the U.S. Geological Survey and other agencies have been studying what is referred to as "hydrothermal activity" in areas where the seafloor is spreading. According to one hypothesis, at the seafloor, ocean water flows down into the earth's crust, where it is heated and then returns to the seafloor nearby. In this process, the water becomes saturated with metals. These metal-rich waters, when chilled by the deep ocean water, precipitate metallic sulfide minerals at the rift margins of these spreading centers.

NOAA scientists have been working with this hypothesis for the past six years to confirm the presence of polymetallic sulfide minerals at former sites of hydrothermal activity. Using special charts developed by a high-technology bathymetric survey on the NOAA vessel Surveyor and bottom photographs, NOAA identified several potential areas. NOAA sponsored a number of dives using the submersible Alvin during August and September 1981. Samples of minerals that were retrieved showed signficant polymetallic sulfide concentrations. To date, NOAA's research has been centered near the Galapagos Islands off South America, because the hydrothermal activity is best understood there. However, using data from the Surveyor, another area off the coast of Oregon and Washington was identified as a source of polymetallic sulfide minerals. The U.S. Geological survey's R/V. Lee recently obtained photographs and samples of polymetallic sulfides at

that site.

From the small number of samples obtained so far, it is impossible to predict if these minerals have any economic potential. However, recent initial assays by the U.S. Bureau of Mines reported encouraging concentrations of metals such as copper, zinc, and silver. As resources permit, NOAA intends to continue this research, in consultation with the private sector and appropriate federal agencies. NOAA anticipates development of a formal program plan during FY 1982.

Need to Amend the Act

At the current time no amendments to the Act are recommended. However, NOAA is analyzing several issues that could lead to future legislative proposals, including possible commercial interest in polymetallic sulfides and the need to establish a legal regime to allow such minerals to be exploited, both off the U.S. coast and in international waters.